



1 0 1 7 0 0 2 0 0 4 / 0 0 0 2 9 9



INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

**PRIORITY
DOCUMENT**
SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH RULE 17.1(a) OR (b)

REC'D 14 APR 2004	
WIPO	PCT

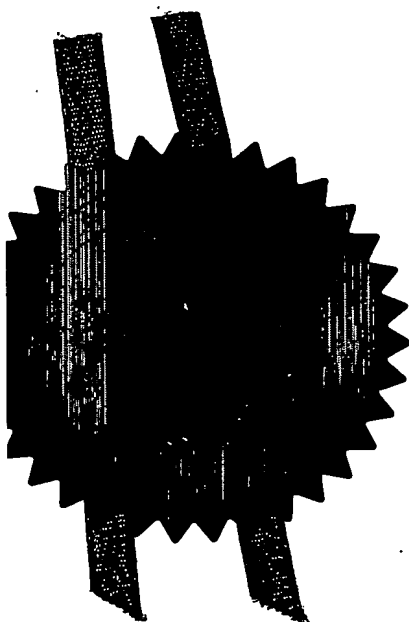
I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

This Page Blank (uspto)



Signed

H. Behen

Dated 22 January 2004

Patents Act 1977
(Rule 16)

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

24 JAN 2003

The Patent Office

Concept House
Cardiff Road
Newport
South Wales NP10 8QQ

1. Your reference MJD/61575/000

27JAN03 E779896-3 002882
P01/7700 0.00-0301718.3

2. Patent application number
(The Patent Office will fill in this part) 0301718.3

3. Full name, address and postcode of the or of each applicant (underline all surnames)
MicroGen Energy Limited
100 Thames Valley Park Drive
Reading
Berkshire
RG6 1PT
United Kingdom

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

GB

8474314001

4. Title of the invention A Stirling Engine Assembly

5. Name of your agent (if you have one) BOULT WADE TENNANT

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

VERULAM GARDENS
70 GRAY'S INN ROAD
LONDON WC1X 8BT

Patents ADP number (if you know it)

42001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number
(if you know it)

Date of filing
(day/month/year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application.

Number of earlier application

Date of filing
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request?

Yes

(Answer 'Yes' if:

- a) any applicant named in part 3 is not an inventor, or
- b) there is an inventor who is not named as an applicant, or
- c) any named applicant is a corporate body.

See note (d))

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form -

Description 6

Claim(s) 1

Abstract -

Drawing(s) 2 12 8 5

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77) 1

Request for substantive examination (Patents Form 10/77)

Any other documents (Please specify)

11

I/We request the grant of a patent on the basis of this application.

Signature

Bart Wade Tennant

Date

24 January 2003

12.

Name and daytime telephone number of person to contact in the United Kingdom

Martyn J Draper
020 7430 7500

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

- a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 01645 500505.
- b) Write your answers in capital letters using black ink or you may type them.
- c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- e) Once you have filled in the form you must remember to sign and date it.
- f) For details of the fee and ways to pay please contact the Patent Office.

A STIRLING ENGINE ASSEMBLY

The present invention relates to a Stirling engine assembly.

5

Stirling engine assemblies are known in the art, for example, WO 99/40309 having a recuperator at the Stirling engine head to heat the air supplied to the burner with combustion gases from the burner. The exterior surface of the recuperator is exposed to the air within the interior of an appliance and hence any heat dissipated from the surface of the recuperator is dissipated into the appliance.

10

The principal purpose of the burner/recuperator assembly is to maintain the temperature of the engine head with the minimum amount of energy. This minimisation of energy is achieved with the use of the recuperator which recovers heat from the burner exhaust gas and uses it to preheat air/gas mixture supplied to the burner. The degree of recuperation and thermal efficiency can be maintained with the use of insulation around the outside of the appliance. However, two factors must be taken into consideration.

20

25

Firstly, the temperature of the incoming air/gas mixture must remain below a critical upper limit. If this limit is exceeded, auto-ignition of the mixture can occur resulting in further over heating and potential damage to the appliance.

30

Secondly, the appliance may house thermally sensitive electrical components which have a nominal maximum temperature. Therefore, the amount of heat dissipated from the burner/recuperator assembly must be maintained at a level to prevent any damage to the electrical components.

35

According to the present invention the Stirling engine assembly comprises a Stirling engine having a head; a burner surrounding the head and comprising a burner element on which a flame is sustained, the
5 burner being fed with a combustible gas stream; a recuperator to preheat the gas stream with combustion products from the burner; and a coolant circuit positioned to absorb heat, which is radiated from the back of the burner element away from the head, into a
10 coolant stream separate from the gas stream.

The present invention uses a burner which surrounds the Stirling engine head to provide particularly effective heat transfer to the head.
15 However, a significant amount of heat radiates away from the burner element which, in turn, can radiate to the recuperator walls and subsequently into the appliance. By removing some of this heat into a separate coolant stream, the temperature of both the
20 incoming gas and the interior of the appliance can be controlled.

The coolant stream for the burner element may be a dedicated stream. However, preferably, the coolant
25 stream is a stream which has cooled the cool end of the Stirling engine. Such a stream is conveniently available and therefore has cost and space benefits.

Preferably, the coolant stream is arranged to
30 subsequently receive heat from the exhaust gas from the burner. In domestic combined heat and power applications, the coolant stream which is heated in this way can be used to supply a domestic heating requirement such as the central heating or water
35 heating. With such an arrangement, a supplementary burner is preferably also provided to supply further heat to the coolant stream to ensure that the domestic

heat demand can be met at all times.

5 A flexible seal may be provided between the burner and the Stirling engine head in order to prevent the escape of gases from the burner into the appliance. In this case, the seal may also be cooled by the coolant stream which is used to cool the burner element. The cooled flexible seal arrangement is the subject of a separate co-pending application GB
10 0211121.9. The burner element and seal may be positioned such that a common duct for the coolant stream can cool both the burner element and seal on a single pass around the head.

15 An example of a burner assembly in accordance with the present invention will now be described with reference to the accompanying drawings, in which:

20 Fig. 1 is a schematic representation of a combined heat and power system incorporating a Stirling engine assembly of the present invention;

Fig. 2 is a cross-section through a Stirling engine assembly of the present invention; and

25 Fig. 3 shows, in cross-section, part of a Stirling engine assembly according to the present invention with a modified cooling arrangement.

30 The domestic combined heat and power system shown in Fig. 1 comprises a Stirling engine assembly 1 together with a supplementary burner 2 and a heat exchanger 3 in which water from a domestic central heating or hot water system is heated by exhaust gas
35 from the Stirling engine assembly and by the supplementary burner.

The Stirling engine assembly 1 comprises a Stirling engine 4 supported on a resilient support 5. A fan 6 provides a supply of combustible gas to a burner 7 surrounding the head 8 of the Stirling engine. The gas is supplied along the gas supply duct 9 and combustion gases which have heated the head 8 subsequently flow along exhaust gas duct 10 which is surrounded by the gas supply duct 9. Exhaust gas is subsequently fed to the heat exchanger 3 where it combines with combustion products from the supplementary burner 2 (which is also fed with combustible gases by fan 6). The combined stream is then exhausted through a concentric flue 11.

The nature of the Stirling engine assembly is shown in more detail in Fig. 2.

In addition to the engine head 8, the Stirling engine comprises an engine cooler 12 and an alternator 13. The internal structure of a Stirling engine is well known in the art and will not be described in greater detail here. An annular absorber mass 14 surrounds the Stirling engine 4 and is resiliently mounted thereto to counteract vibrations of the Stirling engine.

A recuperator 20 is positioned above and around the head 8 of the Stirling engine. The recuperator comprises an outer casing 21 in which a block of insulation 22 is mounted. The gas supply duct 9 is defined between the casing 21 and insulation 22, while the bottom surface of the block of insulation 22 is profiled to define the exhaust gas duct 10 between itself and the Stirling engine head 8. This extends out through top of the casing 21 as shown at 10' in Fig. 2, although this duct is out of the plane of the cross-section of Fig. 2.

The burner 7 has a flame distribution strip 23 which distributes the gas more evenly to the annular burner 7. The majority of the heat from the burner 7 is transmitted by forced convection and radiation to the heater head 8, with the absorption being aided by a system of annular fins 24. Some heat is radiated into the recuperator or radially outwardly of the burner as described in greater detail below.

The Stirling engine 4 will vibrate to a limited degree with respect to the burner 7 and recuperator 20. A flexible seal 25 is therefore provided between the Stirling engine 4 and the burner housing. As shown in Fig. 2, this seal is positioned away from the burner 7 and separated from the burner by a block of insulation 26 in order to limit the temperature that the seal 25 has to withstand.

The cooling arrangement for the Stirling engine is as follows. Cool water which, in a domestic combined heat and power system, has given up its heat to satisfy the domestic heat requirement is initially passed around engine cooler 30 to maintain the cold end 12 of the Stirling engine at the lowest possible temperature. The water is then fed around a seal cooler path 31 surrounding the insulation 26 to absorb heat at this point thereby limiting further the temperature that the seal 25 has to withstand.

The water is then fed to an annular burner cooler path 32 surrounding the burner 7 which absorbs the heat which is radiated outwardly from the flame distribution strip 23. As shown in Fig. 1, the water is then fed to heat exchanger 3 where it is further heated by the exhaust gas from the Stirling engine and by the supplementary burner 2 as described above.

Although the various water paths have been described above as being in series, it is possible for certain of the paths to be arranged in parallel. In particular, the seal cooler path 31 and burner cooler path 32 may be in parallel, with manually adjusted flow control valves located in the parallel flow paths, to enable the flows to be balanced.

As the burner cooler path 32 extracts heat from the burner, the effect of using this is that, in order to maintain the nominal head operating temperature of approximately 550°C, more heat is required from the burner. However, this is offset by an increase in thermal efficiency due to the recovery of heat from the burner that would otherwise have been dissipated into the appliance.

An alternative configuration for cooling the recuperator is shown in Fig. 3. This figure shows only a top left hand portion of the Stirling engine assembly as the remainder of the engine is as shown in Fig. 2.

In the example of Fig. 3, the seal cooler path 31 and burner cooler path 32 have been replaced by a single cooling channel 40. A thermal bridge 41, which is an annular disk of material of high thermal conductivity, provides a heat path from the burner 7 to the cooling channel 40, while the seal 25 is positioned adjacent to the cooling channel 40. This allows the integration of the cooling arrangement for the burner 7 and seal 25 into a single assembly thereby reducing manufacturing costs and materials.

CLAIMS

1. A Stirling engine assembly comprising a Stirling engine having a head; a burner surrounding the head
5 and comprising a burner element on which a flame is sustained, the burner being fed with a combustible gas stream; a recuperator to preheat the gas stream with combustion products from the burner; and a coolant circuit positioned to absorb heat, which is radiated
10 from the back of the burner element away from the head, into a coolant stream separate from the gas stream.

2. An assembly according to claim 1, wherein the
15 coolant stream is configured to pass around a cool end of the Stirling engine prior to passing around the burner element.

3. An assembly according to claim 1, wherein the
20 coolant stream is configured to receive heat from the exhaust gas from the burner after it has passed around the burner element.

4. An assembly according to claim 3, wherein the
25 coolant stream is configured to receive heat from a supplementary burner after it has passed around the burner element.

5. An assembly according to any one of the preceding
30 claims, wherein a flexible seal is provided between the burner and the Stirling engine head in order to prevent the escape of gases from the burner, and the coolant stream is configured to cool the flexible seal.

35
6. An assembly according to claim 5, wherein the coolant stream is configured such that a common duct cools both the burner element and seal on a single pass around the head.

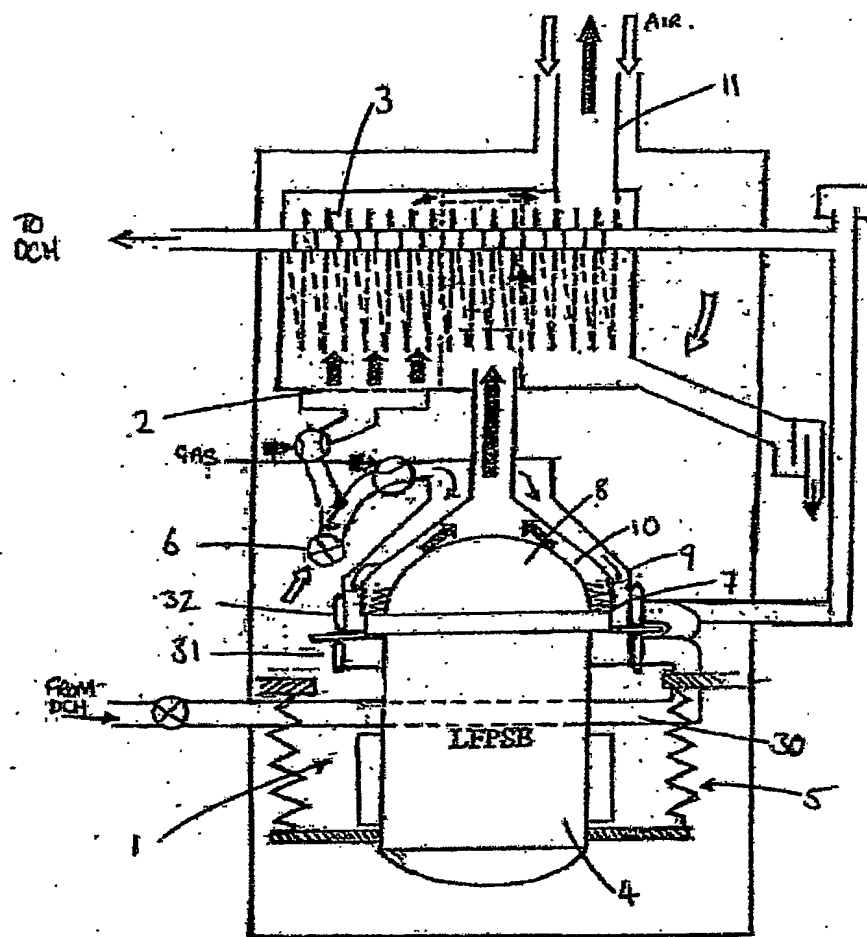


FIG 1

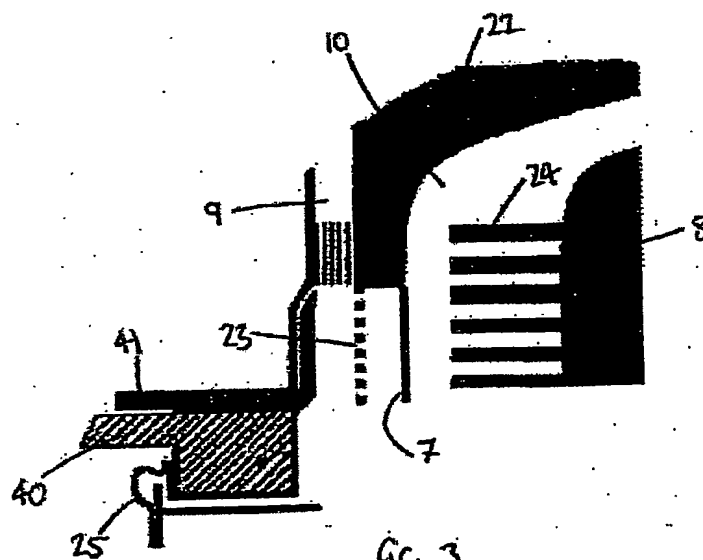


FIG 3

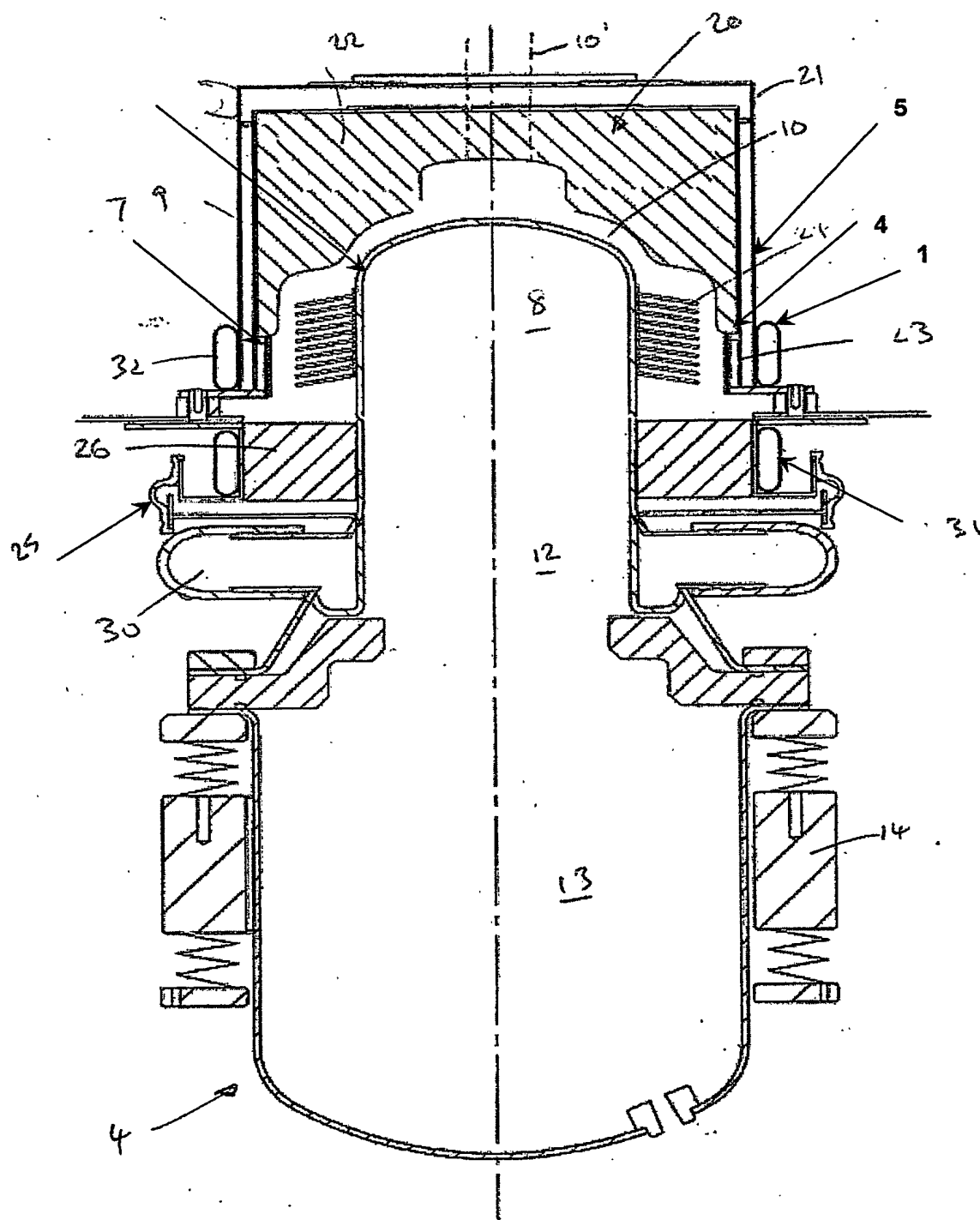
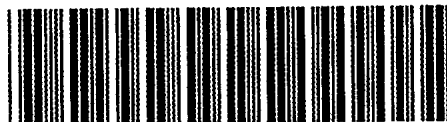


fig 2 .

PCT Application
PCT/GB2004/000299



**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☒ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☒ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☒ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.